The Telegraphic Journal.

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TO OUR READERS.

We need not dwell upon the importance of the applications of Electricity. It would be better to review the position that the chief branch—Telegraphy, a science itself—occupies in relation to the Public. The arrangement of the affairs of commerce is so intimately concerned with the progress of Telegraphy, that it is remarkable there exists no Journal considering both the scientific and the commercial aspects of the science. The requirement which The Telegraphic Journal is intended to fulfil is manifest. It has been admitted practically and by Foreign Engineers that England manufactures telegraphic lines and cables for the world; our cores are unrivalled; our wire is everywhere taken as a standard. Yet while applied sciences of far less extent have several representatives in periodical literature, the applications of electricity have no special organ. The telegraphist, the electrician, the electrotyper, or the electroplater has had to search for the records of his science through a chaos of irrelevant matter, and perhaps has been referred to articles written in a language with which he is unacquainted. In order in the future to collate the literature of the Science to one common centre, The Telegraphic Journal is added to the list of monthly magazines.

The object of the Journal being so clearly apparent, the detail of the arrangement may be proceeded with. The present plan has been the result of much careful deliberation, and it is hoped will be calculated to meet the wants of all our readers.

Each number will contain Leading Articles from the pens of those accustomed to weigh questions of commercial science. In these articles the independence of the Journal will be secured by not seeking aid from departmental or other collective authority; the only authority tolerated in these pages will be born of right and reason. The grievances of operators and of employers will be dealt with alike; delays and dispatch will be recorded as they occur.

There will be Original Papers contributed by eminent Electricians and Scientists whose names will be sufficient recommendation of the high tone of this section. These papers will contain information of value as well to the telegraphist as to the electro-chemist, electrotyper, electroplater, and amateur experimentalist.

The Abstracts of the Proceedings of Scientific Societies will indicate the transactions interesting to the Electrician; while the Reviews of Scientific Books will be conducted in the impartial manner intended to characterise the Journal.

Attention is especially drawn to the Abstracts of all Memoirs which have appeared in the Foreign Journals during the month. In cases where the entire Article will be of interest to our readers, terms will be made with the author to permit a full translation to be published in the pages of The Telegraphic Journal. Our subscribers will thus be kept *au courant* with both foreign and home research.

The Share-Lists and City Notes will form a guide to the Investor interested in the commercial progress of the science or of any particular project. This department will be conducted with the greatest rigour and accuracy.

The Students' Column will comprise articles in Telegraphy and Electricity from the pens of Foreign and English Authors celebrated for their didactic works. This department will often include translations from foreign papers, of which the importance is exceptionally known to the English Student.

A List of Letters Patent applied for and granted will be contributed, and brief or full abstracts will be given in the case of important inventions.

The Editorial Notes of passing events it is unnecessary to describe.

This is our programme. Experience may prove modification to be desirable, and we shall gladly profit by the teachings of experience. But there will be no change in, or modification of, the tone of the Journal, or the determination to overcome any opposition that may present itself.

Thus, then, the ropes are severed, and there is launched into the waters of scientific literature a new bark, named—The Telegraphic Journal.

GOVERNMENT TELEGRAPHY.

The purchase of our telegraphic system by the State is in theory a matter of congratulation for the public, and we even look forward to the railways being bought up in the same manner. We say in theory, because in England the principle obtains that what belongs to the Government belongs to the people. But, unfortunately, in the case of the telegraph, it is too much in theory and too little in fact that we derive benefit from the change which we expected would prove to be so advantageous. We can certainly send messages at a cheaper rate; and we are given to understand that the use of this means of communication has greatly extended under the new *régime*. So far so good; but we hear complaints around us, that the main advantage of telegraphic messages, namely, their speed of transmission, is, to a great extent, denied us. The electric force, indeed, appears to be as willing and as quick as ever; but for reasons best known in Telegraph Street, the length of time taken to transmit a given message is too often reckoned in hours instead of minutes. In the present state of things a case such as this is possible:—A in London intends to call on B, who is about 50 miles away. Regardless of expense, A "flashes" a message to B to notify his intention. He leaves by the next train, arrives at his destination, and finds, much to his own astonishment, that he takes B by surprise. An explanation ensues, during which the tardy message arrives, recording an intention that has become an act. Something of the sort has come within the writer's own experience.

Before the invention of the electric telegraph the natural and obvious difficulty for the transmission of messages at a speed as rapid as that for which the wire offers such facilities, would be to find the practical means. These practical means are provided by science. The difficulty is then surmounted? Not so; there is now another to be overcome, by no means a natural or an obvious difficulty; in fact, a very artificial one; a difficulty created by ourselves, or which we allow others to create for us—it is red tape. The precious moments which are supposed to be gained by "flashing" the message from place to place are allowed to be lost many times over because the telegram must wait on a table for a clerk to sign it. Thus the advantage to be derived from flashing becomes, in many instances, purely imaginary; and if it were not for this sentiment we might often as well have written by post. That is cheaper, more confidential, and a word or two more makes no difference in the price.

Need all this be? Is it absolutely essential that the messages should be allowed such lengthy breathing-times out of consideration for the speed at which they travel. It is urged that if we will send to a crowded wire our messages must wait their turns. But why should the wire be crowded? Why not tell us when it is full. Why receive more work than can well be got through? Speed is the very essential of the telegram; it is its *raison d'être;* therefore there is no good in reducing the charge for this convenience if the convenience itself vanishes. It becomes, in fact, much more expensive. We now pay a shilling for a telegram when a penny stamp or even a half-penny card would have sufficed. In former days a telegram was an outlay, certainly, but we paid much for a speed that we obtained. Many would still pay as much for the same advantage, but find they pay a reduction for a ghost of it. With many a business man the rapid acquisition or transmission of information directly and enormously affects his worldly interests; and it is such men who are among the best customers of the wire, but who are sacrificed for the apparent good of the more general public.

Now we are not opposed to the Government possession of the telegraphic system; we say in theory it is preferable to the possession by private companies; but we see no reason why we should not derive actual benefit from the change. That we do *not* derive actual benefit will, we think, be felt by at least the majority of those who daily use the wire. It appears to us that the evil is not by any means necessary. We speak, however, in considerable ignorance, for so reserved are the authorities of this department as to their arrangements, and so averse to our seeking any useful information on that point, that we cannot prescribe the exact remedy for the evil. But we may bear this in mind —that all the real and practical difficulties would lie in the science of the matter, *i.e.*, in the instruments employed: that the Post Office has the very best instruments at its service. The speed is a marvellous triumph of science; the delay is a created obstruction of routine.

SOME STATISTICS OF SUBMARINE TELEGRAPHY.

Sir James Anderson has perhaps done more to establish a theory of action for the government of submarine companies than has ever been before attempted. He is possessed of exceptional facilities for the collation of statistical returns of the various companies, and he has availed himself of these facilities to induce some rules for the guidance of directors with regard to the tariff of charges for transmission. The results brought forward may be considered as the result of experiments of enormous magnitude with respect both to monetary expenditure and to time. Experience it is proverbial is the best teacher, and the experience of failure is often not the least valuable, leading eventually to direct success. Indeed, success is not always the truest criterion of itself, nor the most secure assurance of its continuance; a failure that has been overcome is rarely presented again in any formidable shape. These results of experiments, then, which Sir James Anderson has brought forward for the first time upon a uniform system, show, first, the effect of reduced tariffs, and, secondly, in the opinion of Sir James Anderson, the principles established up to the present time.

There is first to be considered whether the service is internal or international, because although an internal service has many more units of expense than an international service with regard to the number of clerks employed in transmitting a message, the limit of number of messages supplied by the public is not so soon reached. Hence there must be a limit to the reduction of tariffs, and it remains to be seen by what that limit is represented. In illustration Sir James enters very fully into the case of the Belgian telegraphs, the returns of which show that, "the net product of the Belgian telegraphic system has been diminishing for several years, and was reduced to a point at which there was scarcely any profit in 1868. Nine-tenths of this ought to be attributed to the successive reductions of the tariff upon international telegrams, and the remainder to the reduction upon interior telegrams." This result is due to the development of international service at a much lower ratio than internal correspondence. We can easily trace the cause of this effect, for "social and family relations are never so numerous outside the frontier of any country. They are only 28¼ per cent in the international correspondence, while they constitute 59½ per cent of the internal traffic." The compensation for this, that the commercial telegrams absorb 56¼ per cent of international correspondence, and 34 per cent only of internal service, is not of so much value as may appear at first sight, because the number of international messages is very inferior to the number of messages transmitted from part to part of the interior. "As commercial affairs," continues Sir James Anderson, "constitute the principal object of international correspondence, we cannot hope to increase these relations by any tariff cheap enough to augment the correspondence to anything resembling the increase of telegraphy within the State." From facts, which from their number cannot be introduced here, Sir James summarises the following principles:—

"1. That a reduction of tariff leads to a diminution of the net product, even under the most favourable conditions known.

"2. That the interior service already producing a deficit before the last reduction of tariff, has obtained by these reductions an enormous increase of correspondence, with, however, a slight augmentation of the deficit.

"3. That the international service, which has always given a profit, has realised under similar conditions a development of correspondence much less, and a diminution of benefit much greater, than has resulted to the internal service.

"4. With the interior correspondence the deficit tends to diminish, while with the international correspondence the diminution of benefit tends to increase."

These facts are true of Belgium, but of a less restricted sphere they may not be true, owing to an alteration in the given conditions. Sir James Anderson, however, does not permit the advocate of the "low rate" system to escape so easily, for he immediately produces statistics of Atlantic telegraphy to prove "that a reduction of tariff leads to a diminution of the net product."

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"The actual earnings of the Atlantic Telegraph Companies from 28th July, 1866, to 31st December, 1871, were...	2,171,000
Assuming the tariff to have remained at £12·84 (the mean for the first eleven months), and the traffic to have increased annually at the rate of 12½ per cent, the gross earnings would have amounted to	2,518,000
Difference in favour of £12·84 tariff	347,000
Add—Expenses which would not have been incurred	97,000
Total	£444,000

This statement assumes really one-fourth of the actual traffic attainable with a tariff of £20. The work consequent upon the maintenance of this high tariff would have been sufficiently met by one cable, "the capital and working expenses of the French Atlantic would have been saved, and the Anglo-American Company would now be enjoying 27 per cent dividend upon a capital of £1,675,000." But motives of expediency, competition, combination to prevent opposition, have conduced to the cheapening of the rates with the results known.

Applying the existing data, Sir James Anderson proceeds to consider the prospects of the projected Atlantic cables, and it will be instructive to follow his reasoning.

	£
"We have already three Atlantic cables laid, and in good working order, represented by a capital of	3,675,000
There are two additional cables projected, one to be laid by the French Atlantic Company at a cost of £900,000, and another by the Great Western Telegraph Company, whose capital is £1,350,000, making together	2,250,000
Total...	£5,925,000

"The revenue earned by the Atlantic cables, including the Newfoundland Company's portion, amounted, as far as can be ascertained from the published accounts of the companies for the year 1871, to £610,000. During the first six months of that year a £3 tariff was in force, and during the last six months £2 was charged. Taking the mean rate of £2 10s., we can assume that 245,000 messages were sent.

"From existing data we can say that the normal increase of traffic may be estimated at 25 per cent, which would give a total of 306,250 messages for the current year, and 382,812 for 1873.

"The effect of lowering the tariff from £2 to £1 will probably be to increase the number of messages 75 per cent in the first year after the reduction.

"As the two new cables cannot be laid until after the lapse of the first six months of next year, we may estimate—

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The number of messages for the June half-year of 1873 at 191,406; these at a £2 tariff will give a revenue of	382,812
Upon the assumption of a £1 tariff increasing the traffic 75 per cent, the number of messages for the second half of 1873 would be 334,960, and the total revenue for the six months	334,960
Together	£717,772

"Estimating the expenses attending the working of the five cables at £110,000 per annum, the balance of revenue for 1873 would yield upon the gross capital about 10 per cent for dividend and reserve.

"But for 1874, supposing the regular increase of traffic to be 25 per cent upon the number of messages sent in 1873, the total revenue at a £1 tariff would only be £657,957, and this less working charges would return on the gross capital 9 per cent for dividend, reserve, and repairs.

"It cannot be disputed that Atlantic telegraphy under a self-supporting tariff would within ten years require several additional cables.

"The experience of Indian traffic confirms all the foregoing principles, and it follows that, if we are to have a low tariff, calculated to stimulate this class of correspondence, increase commercial activity, and make telegraphy more of a habit of the people in India, it must be done at a sacrifice of dividends at least, and these are for the present at as low a point as private investors will encourage.

"We propose from the first of next month to reduce the tariff from £4 10s. to £4, and there is a hope that the traffic will be elastic enough to recoup within the first year the loss from this moderate reduction. Government alone can afford to bring the tariff to £3, a tariff which would keep the lines self-supporting, and provide for the extensions which the certain increase of commercial activity from this cause alone would demand."

This evidence of so experienced a director as Sir James Anderson as to the impossibility of establishing low rates is, to say the least, discouraging, and shows that it will be necessary that Government should either grant under certain regulations a monopoly to the companies to protect them from competition if they maintain a moderate tariff, or it must purchase the whole system of cables for the public benefit. Increase of internal traffic decreases the cost of working international telegrams, but only the Government derives advantages from this, and not the private companies, whilst Government should look not to profit, but to the benefit of the community,—obviously what no reasonable man would expect from a private company. Sir James Anderson has given a most powerful argument; but were the Government to purchase all cables and lines, what guarantee would the public possess (such as competition now gives) against delay and inaccuracy? What we should gain in cheapness might be dearly paid for in other respects.

AN APPLICATION OF MAGNETO-ELECTRICITY BY SIR CHARLES WHEATSTONE.

Many means have been devised for the purpose of registering at a distance the periodical motions of a machine, or the number of changes in the position of a turnstile or a door. Those of the earliest date are merely mechanical, and their use is limited by the short distance to which the motions can be communicated. Mechanical registers are of necessity cumbrous, and must remain exposed to view and dust, or be covered at great expense.

So far back as 1840 Sir C. Wheatstone invented an instrument for this purpose, founded on the principles of his electro-magnetic step-by-step telegraph when voltaic electricity was applied thereto. But batteries involve troublesome chemical operations, and if not constantly attended to their inactivity causes the failure of the entire system. Voltaic batteries are subject to many accidents through which a temporary irregularity in the registration may ensue; they may be situated in so cold a place that in winter the exciting liquid is frozen or the vases cracked; or they may be exposed to the heat radiated from hot-air or water-pipes or other source of warmth, and the liquid evaporated to crystallisation, the crystals forming a non-conducting coat upon the electrodes of the pile. But, given success with the battery, the rapidly succeeding contacts render constant inspection necessary. The spark that appears on breaking contact is nothing less than a minute particle of the metal of the contact-point in a state of incandescence, and it follows that where the current passes and is interrupted many times a minute, the contact-points must speedily be worn away. This difficulty was subsequently overcome by the inventor employing magneto-electric currents, and the following is a description of a suitable apparatus for the generation of these currents in which the circuit is never broken.

Fig. 1.

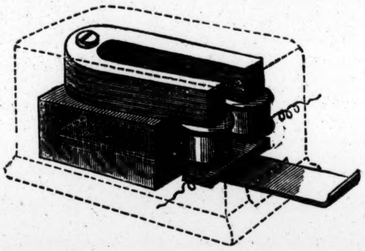
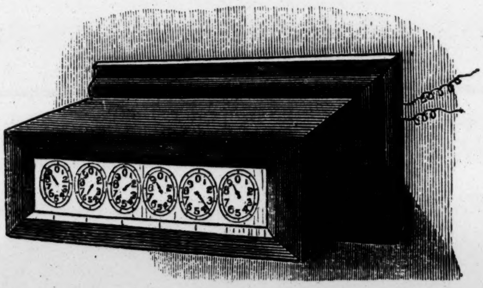


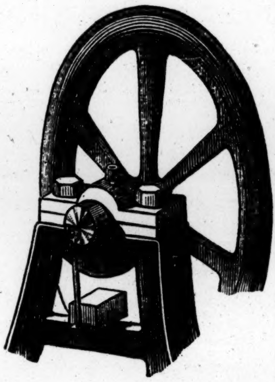
Fig. 2.



On reference to Fig. 1 it will be seen that the essentials of the apparatus are a small permanent magnet, two coils of fine wire with soft iron cores, and an armature of soft iron. The spring to which the armature is attached presses the armature against the soft iron cores of the bobbins, maintaining the strength of the magnet when the apparatus is not in use. When by pressure on the lever the armature is quickly removed from the poles of the magnet, a current is induced in the coils of wire, and is communicated by leading wires to the register or indicator, Fig. 2,[*] where it acts by means of an electro-magnet upon a step-by-step motion precisely similar to the motion imparted to the needle of the receiving instrument of the A B C telegraph. On the return of the armature into contact with the soft iron prolongations of the permanent magnet a current is generated in an opposite direction to the first. The first current caused the hand of the indicator to advance half the distance between two of the figures upon the dial; the second current completes the movement, and records one action of the machine to which the apparatus may be attached. Thus in the case where it is desired to record the number of visitors entering a building through a door, the opening of the door causes the needle to advance half a space, and the closing of the door completes the record of the number. In this manner it is easy to ascertain in a distant part of the building not only how many times the door has been opened and closed, but also the duration of the time occupied in the act of opening, and whether the door is standing permanently open or not.

In the *Times* printing office several of these automatic registers are employed to record the number of impressions produced by the various printing machines. The registers are placed in the office of the manager, and the generators are attached to the presses in the printing-room; by this arrangement the number of impressions per given time can be recorded, and any delay in the working of the machine noted. In the office of the newspaper in question a complete apparatus is attached to each printing machine, affording a more perfect control of the printing-room than could be attained by personal supervision. The method of concentreing the lever of the armature to a machine is illustrated in Fig. 3. Among other applications of this instrument, perhaps the most appropriate is to the measurement of the length of cable made and coiled in Messrs. Hooper's works.

FIG. 3.



SIR JAMES ANDERSON'S ACCOUNT OF MARINE CABLES LAID.[†]

THIS is by no means a new subject for investigation, but in the present day I am certain that it will be instructive to many amongst the thousands who are now interested in this class of property, to have their attention briefly called to all that has been done to make submarine cables a sound property.

Eleven years ago there was a joint committee appointed by the "Lords of the Committee of Privy Council for Trade and Atlantic Telegraphy, to inquire into the construction of submarine cables, together with other evidence." Attention is called in the report to the "remarkable fact that in almost all cases small cables had been found liable to mishaps, while the heavier the cable had been the greater had been its durability." The report is full and complete, and establishes principles which up to the present time have uniformly guaranteed success, while the neglect of them has as uniformly resulted in partial loss or failure.

The loss of cables was found to be attributable to the following causes:—First, and the most important of all, from imperfect manufacture, resulting without doubt prior to this date from inexperience of the materials for insulating the copper wire, and from ignorance of the fact discovered by Professor Thomson about 1856, viz., that some kinds of copper wire were no better than iron for the purpose of conductivity, and that it required carefully selected copper to give the desired standard, which may be represented by a copper wire one-tenth of an inch in diameter, being equal to an iron wire one-third of an inch in diameter for electrical purposes. All cables manufactured previous to this date had no advantage from this discovery.

There appear to have been mechanical difficulties in keeping the copper conductor in the centre of the insulating medium, so that the copper was sometimes found to be almost visible under the light film of gutta-percha which covered it. The electric current soon weakened this film, stronger currents were used to overcome the weakness of the signals, and the cable was soon destroyed. Experience about this time had established that a cable from the commencement of its manufacture to the time of its being laid should be tested under water and under pressure, and kept as much as possible under all the conditions in which it was meant to continue.

Attempts to lay cables from sailing ships towed by steamers was another source of failure. The ships had not enough steerage way when met by strong head winds, and too much slack was paid out. It was difficult under such circumstances to steer a straight course, and sailing ships possessed no power of being readily stopped when a fault or accident occurred.

Many accidents happened from inexperience in the method of paying out cables; at the present day the wonder is that they should have succeeded so well with the rude methods and inexperience which then existed, and not that there should have been many failures and much recrimination. Reading the history of these first attempts to place a network of cables at the bottom of the ocean fifteen and twenty years ago, is a good deal like reading the old stories of the early voyages of discovery. There are difficulties and disasters peculiar to every attempt, and the grand result is that one way or another they were overcome, or else they suggested such modifications that their recurrence was avoided, and an accident to a well-manufactured cable no longer constitutes a loss.

The first Atlantic cable failed principally on account of imperfect manufacture, in a great measure arising from undue haste and urgency, but largely owing to insufficient experience. The cable was not tested under water for fear of rusting the small steel wires of the external covering, and small wires have never since been used; large wires, the larger the better, is now a principle. The copper was not all good. It had often been coiled and uncoiled, and had been exposed to the strong heat of the sun, and to many changes of temperature. Any of these conditions would now-a-days be regarded as enough to condemn the most carefully-manufactured cable.

The Red Sea and Indian cables are said to have been imperfectly manufactured and laid too taut, but they were not tested under water from the time of manufacture until they were placed at the bottom of the sea, and this one grand omission, largely due to inexperience, is enough without the recriminatory points to condemn to loss and failure any cable whatever.

The cables laid from Cagliari to Malta and Malta to Corfu are said to have failed from imperfect manufacture. One experienced gentlemen in his evidence said these cables were "such as nobody should have laid in deep water." It is sufficient at present to know that they have failed from neglect or inexperience, and that they, amongst other failures, have established the principles which have since ensured success.

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[*] The dimensions of the counter, registering to ten millions, are 10½ inches in length, 3¾ in breadth, and 3¾ in height, but they are made to register to any smaller number.

[†] Abstract of a Paper read before the Statistical Society.

The want of constant supervision by engineers, exclusively in the interests of the purchasers of the cable, has been a great cause of defective cables. There may often be minute defects in the core itself, or a slightly defective splice which may reduce the electrical condition of a comparatively short length; this may easily be raised above the average standard required by the contract, by the next length being more carefully manufactured. These minute defects must, however, kill the cable in more or less time, and the principle is established that every inch should be tested in course of manufacture, and rejected if there is any irregularity of condition to cause suspicion. There should be constant supervision, and a record of all the tests kept for the purchasers of the cable from the commencement of the contract to its final completion, and continued ever afterwards by the purchasers.

The principal sources of injury to cables are—1st, moving water either currents or tides, chafing the cables upon rocks or shingle. Experience has given many costly lessons of the effect of moving water.

Ten years ago it was generally believed that water had very little motion below 50 fathoms, and 100 fathoms was considered a point of great safety. We now know that there are exceptional localities where there is motion in the water at a depth of 500 fathoms. The Falmouth cable was chafed and destroyed at this depth from this cause. The Channel Islands cable was also destroyed from the same cause. The first cable ever manufactured with due regard to the principle of careful supervision, testing under water, and being retained quietly in that condition until it was laid, was the Malta and Alexandria cable laid in 1861. This cable was submerged in too shallow water, for many miles in less depth than 20 fathoms; the result was the frequent recurrence of fracture from being rolled about by the surf, and yet this cable was only finally abandoned last year; not because it could not be kept in repair, but because it was too expensive to keep in order. These and many other examples have established the principle that no cable should be laid without first obtaining an accurate survey of the approach to the coast and landing places, with accurate soundings over the intended route, and as much knowledge as possible of the nature of the bottom. Currents and anchorage should be avoided, and where that is impossible, the heaviest cable that can be laid should be provided. Heavy cables should be laid out to depths of 400 fathoms, where there are tide-ways. Where a current exists, a position should be sought for as far removed from it as possible. A great cause of injury to cables is the corrosion of the external wires, caused by moving water or marine vegetation, &c., and this has established the general practice of covering the external wires with tarred yarn saturated with a mixture of pitch and silica. There is still great room for improvement upon the present method of protecting the external covering of cables, and I commend it to the further careful study of telegraph engineers as a subject of vital importance.

Another enemy of submarine cables is the teredo of all kinds; there is one kind which has proved destructive by boring through the core, but that has only occurred in shallow water; there is another kind which destroys the hemp in a few months, and is then satisfied to fix itself upon the gutta-percha and remain there. Cables have been recovered from depths of 1200 fathoms with all the hemp eaten away, and the core pitted with these marine animals. The recovery is then only possible by the strength of the external wires.

All the experience we have points to the value of protection, first, of the core, then of the external covering, and if those responsible for the safety and maintenance of submarine cables could be allowed to dictate the most desirable conditions of safety they would select, besides the strongest possible cable to be manufactured, and laid with extreme care, a depth of water of about 500 fathoms, and a bottom of sand or mud; but as this cannot always be secured nothing should be omitted in the direction of strength and quality.

Lightning is still another source of injury to cables; this is, however, so readily guarded against that we no longer hear of injury from this cause; it is said to have destroyed three cables. Mr. Siemens produced before the committee a piece of the core of the Corfu cable injured by lightning; the land line had been struck, and from the absence of any lightning guards, the cable was damaged. Mr. Preece described the Jersey cable to have been destroyed by lightning. Mr. Fleeming Jenkin had seen a fault 18 inches long due to this cause, and it is asserted that the same cause destroyed the Toulon-Algiers cable, which was connected to the land lines without lightning guards.

We are every now and then startled by the announcement that light cables are to be preferred to the present iron-clad type, and the object of this investigation has been to discover what data there are to justify any preference to one form of cable over another. I have said already that the committee called attention to the remarkable fact, that in almost all cases, small cables had been found liable to mishaps, while the heavier the cable the greater had been its durability.

Mr. Newall, in his evidence, said that the hemp-covered cable which he attempted to lay in 1859, between Candia and Egypt, had the hemp eaten off by the teredo in a very short time, and it was too weak to recover for repairing. The same firm laid an unprotected core from Varna to the Crimea, and it lasted until the winter set in; it is frequently said that it was cut by order of the French Commander-in-Chief, but there is no proof of this, and I am not disposed to believe it. Mr. Woodehouse, the engineer who laid this core, said in his evidence "he should not advise anybody to lay so light a cable across the Atlantic, because so small a strain would break it. If it is once safe at the bottom perhaps it may rest." Mr. Newall said he thought it folly to lay anything excepting unprotected core. Consistently with this conviction, he laid in 1869 several lines of unprotected india-rubber core, connecting the Grecian Islands with the main land; they were protected only near the shore. The sea is quiet and tideless in those parts; no better spot could be wished tor the experiment, yet they every one of them gave out within two years.

The Red Sea cable, covered externally with light wires, and unprotected with bituminous compound, was so rusted in a short time that it could not be lifted for repairs.

Notwithstanding Mr. Newall's partiality for light cables, he suggests at the close of his evidence what I assume he would consider the most perfect form of cable. He would cover the copper with india-rubber, protect this core with steel wires vulcanised, the whole then passed through heat; thus insulating all the wires he would make the cable in one length, and have no joints.

Mr. Fleeming Jenkin in his report to the International Exhibition of 1862, says:—

"So long as the iron wires lasted, the cables frequently continued to work in spite of faults, but sooner or later the iron wires of all these light cables rusted away in parts; so soon as this took place they one and all broke up into short sections; this fact has been observed in depths of 100 fathoms; the reasons were not obvious to Mr. Jenkin, but he says:—"meanwhile the use of large iron wire seems a sure guarantee against this danger, for as yet no cable covered with wire of the large gauges has ever parted in the manner described."

"The difficulty is to find a permanent material which shall retain its strength and continue to afford protection after the cable is laid."

Every word of this can be written at the present moment, that is, ten years later, with exactly the same significance. All cables which have been manufactured and laid upon the principles which were established in 1859, are yet in good working order, and every divergence from these principles has been at best a costly experiment or utter failure. There is no instance yet of a well-manufactured heavy cable breaking or giving out in deep water after it has been carefully laid free from defects; but there may be much due to the external covering keeping it quiet; there has assuredly been a great deal due to the external covering in the successful submerging, and there is no experience whatever to justify the assumption that an unprotected core would last, even if laid.

It has been urged that an iron-covered cable suspended from one point to another gradually becomes weaker, that rust and marine growth or deposit accumulates and breaks the cable with their weight; but I do not know of any instance in support of this assumption, nor is it at all certain that a simple unprotected core would exist for any length of time, or be in any way better adapted for the supposed conditions. Mr. Latimer Clark in his evidence says:—"You want a certain degree of weight to enable your cable to sink steadily to the bottom, especially when it has to fall into hollows and cavities, and not lay loosely across elevations."

Again, it is urged that experiments with light cables have been tried in factories or sheds, and the result proves that there are many advantages in their favour; but I am of opinion that no experiments which can be made on shore will sufficiently resemble the exigencies which may occur over a period of several days and nights at sea in storms and darkness, and still less will they prove their fitness for the unknown conditions which may exist at great ocean depths. I desire to write with great respect for the opinions of the talented men who urge the adoption of light cables; it is my special duty to weigh well and without prejudice all they have to advance; but I think a careful investigation into the experience and practice of the last twenty years establishes conclusively that all light cables have been short-lived, and that all heavy cables have continued working, often under most adverse conditions. It is my own opinion, and I am authorised to say that it is also the opinion of my friend Captain Halpin, who has laid all the cables from Suez to Australia, besides the French Atlantic cable (11,000 miles), and has also recovered and repaired cables from a great variety of depths—that a cable should be as heavy as it can be laid with safety, and admit of being recovered in case of accident. Multiply every precaution which shall increase the strength and keep that strength in tact as long as possible.

The best form of light cable I have seen is the copper-covered core invented by Mr. Siemens (No. 8). I should have anticipated that if any light cable could have been successful, this one would have met all the conditions, excepting that of extreme cheapness, but it has not been so uniformly successful as the heavy iron-clad cables. The very light cable invented by Mr. Varley (No. 21) admits of being laid by having the strain taken off the core by the two hempen strands, the core itself being the third strand of the cable. As a light cable to be manufactured in a great hurry and laid to meet some emergency, it has a good deal of merit, but for a deep sea cable I am of opinion that it would be found too incomplete and unfinished, and that difficulties would be experienced in laying, which are not at once foreseen, and that there would be no durability even if successfully laid.

Every day of my experience in watching over the permanence of the 10,000 miles of cable under my care, confirms me in the opinion that too great caution and vigilance cannot be exercised in making and laying a thread which is to be removed from all human vision for ever, and designed to earn dividends by continuing a perfect conductor of electricity. Upwards of 30,000 miles of cable have been laid since the report of the committee, was printed, eleven years ago, and much experience has been gained of the exigencies incidental to submerging, buoying, grappling, and repairing; but no fact has resulted from all that experience which has established that any one precaution recommended in the report has been superfluous, whereas much has occurred, which I will not particularise, proving that any attempt to disregard any single precaution has resulted in great pecuniary loss or utter failure.

We have many reasons to confirm the belief that a submarine cable, manufactured and laid with strict attention to all known principles, may be regarded as a substantial property, likely to last for any length of time; for there is no evidence whatever upon record which shows any decay of the insulating medium or copper conductor of a well-manufactured cable, *i.e.*, there is no decay inherent in the nature of a cable; all deterioration is external; nor is there any experience whatever to establish that this insulated copper wire will enjoy any durability if unprotected with an external covering.

A light cable or unprotected core must therefore be regarded at best as an experiment, with the chances against the successful laying, and still more against its existing as a permanent property.

I have written enough to illustrate that the present submarine cable (No. 9) is not a haphazard idea, but one which has grown out of many failures and thousands of experiments; all the principles of manufacture and laying down have been established by great anxiety and reflection on the part of the able men who gave their energies to this kind of enterprise prior to 1865. We who have come upon the stage since that date, have only discovered that we may not neglect one of all the known principles, but if possible elaborate every one of them, and even then the duty and responsibility of laying and maintaining this class of property, has enough of risks and anxieties to make one heartily dislike any experiment which can only be advocated for the sake of cheapness in the first cost. I believe this economy would be at the expense of security, and that the cable of the future will be even heavier, more perfect, and more costly than the cable of the present day.

LIST OF THE CABLES, THEIR LENGTH AND WEIGHT, AND SEA DEPTH.†

(* Not working February, 1872.)

Date.	From	To	Length in Miles.	Weight per Mile in Tons.	Greatest Depth in Fathoms.
1850	*Dover	Calais	25	0·2	30
1851	Dover	Calais	25	6·0	30
1852	Keyhaven ..	Hurst Castle	3	—	20
	*Holyhead ..	Howth ..	65	1·57	83
	*Port Patrick	Donaghadee	15	—	160
	* ,, ,, ..	,,	—	—	149
	*Prince Edward Island ..	—	12	—	18

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† From the "Journal of the Statistical Society."

Date.	From	To	Length in Miles.	Weight per Mile in Tons.	Greatest Depth in Fathoms.
1853	Denmark across Belt	—	18	4·0	15
	River Tay	—	2	—	—
	Dover	Ostend	76	5·75	30
	Firth of Forth	—	5	1·75	7
	Port Patrick	Donaghadee	25	6·0	160
	*England	Holland	115	1·75	23
1854	Port Patrick	Whitehead	27	6·0	150
	Sweden	Denmark	12	6·0	14
	*Corsica	Sardinia	10	8·0	20
	*England	Holland	120	1·75	30
	*Holyhead	Howth	65	2·0	80
	*Spezzia	Corsica	110	8·0	325
	Holyhead	Howth	65	2·0	83
1855	*Sardinia	Africa	50	8·0	800
	*Cape Ray	Cape North	74	2·2	360
	*Sardinia	Africa	160	3·7	1500
	*Varna	Balaclava	310	2⅛cwt.	300
	*Eupatoria	,,	60	0·75	69
	*Varna	Kilia	179	—	30
	Egypt	—	10	5·25	—
	*Italy	Sicily	5	5·25	27
	*England	Holland	123	—	23
	* ,,	,,	119	—	23
1856	*Cape Ray	Cape North	85	2·5	300
	Prince Edward Island	—	12	2·5	14
	Across Gulf of Canso	—	1½	2·2	—
	*Crete	Alexandria	350	—	1350
	* ,,	Syra	170	—	1020
	St. Petersburg	Cronstadt	10	—	10
	Bosphorus	—	1	—	40
	Across Amazon	—	105	—	—
1857	*Sardinia	Bona	150	1·85	1500
	* ,,	Malta	500	0·9	1000
	*Corfu	,,	500	0·9	1000
	*Portland	Alderney	69	2·5	60
	*Alderney	Guernsey	17	2·5	44
	*Guernsey	Jersey	15	2·5	60
	Norway Fiords	—	49	2·75	300
	Ceylon	Mainland	30	2·75	45
	Danube	—	3	1·75	—
	Ceylon	Mainland	30	2·75	40
1858	*Italy	Sicily	8	5·25	40
	England	Holland	129	9·75	27
	*Cromer	Emden	280	3·0	28
	Norway Fiords	—	16	2·75	300
	*Atlantic	—	2036	1·0	2400
	*Dardenelles	Khios	565	0·94	1100
	*Khios	Syra			
	*Syra	Athens			
	*Khios	Smyrna			
1859	*Crete	Alexandria	150	—	1600
	* ,,	,,	—	0·9	1350
	*Singapore	Batavia	630	0·94	20
	Denmark	Heligoland	46	4·0	28
	*Cromer	,,	328	4·0	30
	Isle of Man	Whitehaven	36	2·5	30
	Sweden	Gottland	64	2·5	70
	Folkestone	Boulogne	24	9·5	30
	India Rivers	—	10	4·5	—
	Malta	Sicily	60	3·25	75
	Jersey	Pirou	21	3·75	10
	*Otranto	Avlona	50	0·9	400
	*Ceuta	Algeciras	25	1·0	700
	Alexandria	—	2	—	—
	Lynas	Great Ormes Head	19	3·1	14
1859	Ayr	Mimbre Island	19	3·1	14
	*Cape Otway	King's ,,	240	2·0	60
	*King's Island	Hummuck ,,			
	*Hummuck Island	Circular Head			
1860	Great Belt	—	14	8·0	18
	,, ,,	—	14	5·5	18
	*Dacca	Pegu	116	0·9	50
	*Port Vendres	Algiers	520	1·14	1585
1859 & 1860	*Suez	Cassire	255	0·94	Shoal water
1860	*Suakin	Cassire	474		
	* ,,	Aden	627		
	*Aden	Hellania	718		
	*Hellania	Muscat	486		
	*Muscat	Kurrachee	481		
	*Barcelona	Mahon	198	1·25	1400
	*Minorca	Majorca	35	1·9	250
	Iviza	,,	74	1·9	500
	*St. Antonio	Iviza	76	1·9	450
1861	Corfu	Otranto	—	3·4	1000
	*Malta	Tripoli	230	2·5	385
	*Tripoli	Bengazi	508	1·85	420
	*Bengazi	Alexandria	593	4·5 6·0	80
	Norway Fiords	—	—	2·75	300
	Dieppe	Newhaven	80	8·0	25
	*Toulon	Corsica	195	1·14	1550
1862	Wexford	Abermam	63	5·25	50
	Lowestoft	Zandvoort	125	9·0	27
	Across Cork Harbour	—	—	0·6	—
	Across Blackwater	—	—	1·75	—
	Greencastle	Cape Clear	—	—	—
	Bristol Channel	—	—	3·5	26
1863	*Cagliari	Sicily	211	1·8	1025
1864	*Cartagena	Oran	130	—	1420
	Gwadur	Elphinstone Inlet	357	4·3	437
	Mussendon	Bushire	393		97
	Bushire	Fao	154		19
	Gwadur	Kurrachee	246		670
	Otranto	Avlona	50	4·0	347
1865	Indian Rivers	—	—	—	—
	Sylt	Tondern	6	—	—
	*Bona	Sicily	270	—	250
	Trelleborg	Rugen	55	8·0	80
	Sth. Foreland	Cape Grisney	25	—	30
1866	Atlantic	—	1896	1·75	2424
	,,	—	1852	1·5	2424
	Lyall's Bay	White's Bay	41K	9·1	50
	Crimea	Circassia	40	—	—
	Colonia	Buenos Ayres	30	12·0	4
	England	Hanover	224	10·9	27
	Cape Ray	Aspee Bay	91	—	200
	Leghorn	Corsica	65	—	100
	Persian Gulf	Additional cable to connect Jask	160	—	110
	*Khios	Crete	200	—	1200

Date.	From	To	Length in Miles.	Weight per Mile in Tons.	Greatest Depth in Fathoms.
1857	Sth. Foreland	La Panne	47K	9·7	28
	Ceylon	—	—	—	10
	Malta	Alexandria	925K	1·5	2000
	Havana, Cuba	Key West	125	2·5	20
	Key West	Punta Russa	120	2·5	20
	Placentia	St. Pierre	112	2·5	76
	St. Pierre	Sydney	188	2·5	250
	Arendal	Hirtshalts	66	—	110
1868	Messina Straits	—	5	6·0	40
	Havanna	Key West	125	—	—
1869	Peterhead	Egursand	250	3·0	70
	Grisselhamn	Nystadt	96	3·0	47
	Newbiggin	Sondervig	334	—	48
	*Black Sea	—	300	—	—
	*Scilly Isles	Land's End	27	6·0	40
	Malta	Sicily	54	1·5	75
	Tasmania	Australia	176	2·0	—
	Scilly Isles	Land's End	27	3·0	42
	*Corfu	Sta. Maura	50	—	160
	*Sta. Maura	Ithaca	7	—	180
	Ithaca	Cephalonia	7	—	—
	*Cephalonia	Zante	10	—	60
	Bushire	Jask	505	4·3	97
	Brest	St. Pierre	2584	1·6	2760
	St. Pierre	Duxbury	749	2·8	259
	Moen	Bornholm	80	4·0	28
	Bornholm	Libau	230	3·5	62
1870	Scotland	Orkney Isles	—	—	37
	Salcombe	Brignogan	101	2·78	59
	Beachy Head	Cape Antifer	70	11·75	34
	Suez	Aden	1460	2·75	968
	Aden	Bombay	1818	1·75	2060
	Porthcurno	Lisbon	823	1·6	2625
	Lisbon	Gibraltar	331	1·5	535
	Gibraltar	Malta	1120	1·5	1450
	*Porthcurno	Mid Channel	65	—	62
	Marseilles	Bona	447	1·75	1600
	Bona	Malta	386	1·75	650
	Madras	Penang	1408	1·4	1284
	Penang	Singapore	400	3·4	36
	Singapore	Batavia	557	3·5	22
	Malta	Alexandria	904	1·5	1440
	Batabano	Santiago	—	—	—
	Jersey	Guernsey	16	7·0	32
	Guernsey	Alderney	18	7·0	30
	Sta. Maura	Ithaca	7	3·5	180
	Zante	Trepito	11	3·5	235
	Sunium	Thermia	25	3·5	160
	Patras	Lepanto	2	3·5	20
	Dartmouth	Guernsey	—	—	58
	Guernsey	Jersey	—	—	32
	Porto Rico	St. Thomas	110	—	22
	Santiago	Jamaica	140	—	—
	Portpatrick	Donaghadee	25	—	160
1871	Javea	Iviza	—	2·75	430
	Majorca	Minorca	—		93
	Villa Real	Gibraltar	155	3·5	84
	Marseilles	Algiers	—	—	1625
	Singapore	Saigon	620	2·5	60
	Saigon	Hong Kong	975	3·5	630
	Hong Kong	Shanghai	1100	—	42
	Shanghai	Nagasaki	1200	—	135
	Nagasaki	Vladivostock			80
	Rhodes	Marmarice	22	—	—
	Latakiah	Cyprus	86	—	—
	Samos	Scala Nuova	11	1·5 main	82
	Mytelini	Aivali	13	2·5 inter	33
	Khania	Retimo	32	6·0 S.E.	about 200
	Retimo	Khandia	41	—	152
1871	Khandia	Rhodes	201	—	600
	Khios	Chesmeh	6	—	33
	Zante	Corfu	150	—	—
	,,	Cephalonia	18	—	203
	Lowestoft	Creitseil	223	7·5	23
	Anjer	Telok Betong	55	3·5	50
	Banjoewangie	Port Darwin	1082	3·5	1580
	St. Thomas	St. Kitts	133	—	1170
	St. Kitts	Antigua	90	—	130
	Antigua	Guadaloupe	84	—	—
	Guadaloupe	Dominica	55	—	—
	Dominica	Martinique	60	—	—
	Martinique	St. Lucia	65	—	—
	St. Lucia	St. Vincent	64	—	—
	St. Vincent	Barbadoes	150	—	—
	,, ,,	Grenada	80	—	156
	Grenada	Trinidad	120	—	—
	Trinidad	Demerara	350	—	—
	Porto Rico	Jamaica	—	—	—

Total number of cables 213
Total length in miles 45,783½

ON A

VOLTAIC STANDARD OF ELECTRO-MOTIVE FORCE.*

By LATIMER CLARK, M.I.C.E.

In the year 1861 a Committee was appointed by the British Association for the Advancement of Science to report on standards of electrical resistance, and subsequently on other standards of electrical measurements. Reports were presented in 1862, 1863, 1864, 1865, and 1867.

They recommended the adoption of a system of electro-magnetic units based on the metre and gramme, the relations of the units being such that the unit of electro-motive force acting through the unit resistance should give the unit current, and that the unit current flowing for the unit time should give the unit quantity.

They issued standards of resistance (known as the B. A. unit or ohm) and standards of electrostatic capacity, or condensers of such magnitude that when charged with the unit electro-motive force they contained a sub-multiple of the unit quantity of electricity (known as the farad).

No material standard of electro-motive force has yet been issued. Much difficulty has, in fact, been found in devising such a standard. Mechanical means, such as the rotation of a conductor in a magnetic field of known intensity, are too complicated for ordinary use; thermo-electric couples are extremely variable, and voltaic elements, which would constitute the most convenient form of standard, have been hitherto found singularly inconstant, and therefore inapplicable. The Daniell's element, which has been most frequently used for this purpose, commonly varies 5 per cent or more without apparent cause.

From a conviction that if similar conditions could be ensured similar combinations would always give the same electro-motive force, the author was led to institute a series of experiments, extending over four years, which led to the discovery of a form of battery that is sensibly constant and uniform in its electro-motive force.

The battery is composed of pure mercury as the negative element, the mercury being covered by a paste made by boiling mercurous sulphate in a thoroughly saturated solution of zinc sulphate, the positive element consisting of pure zinc resting on the paste.

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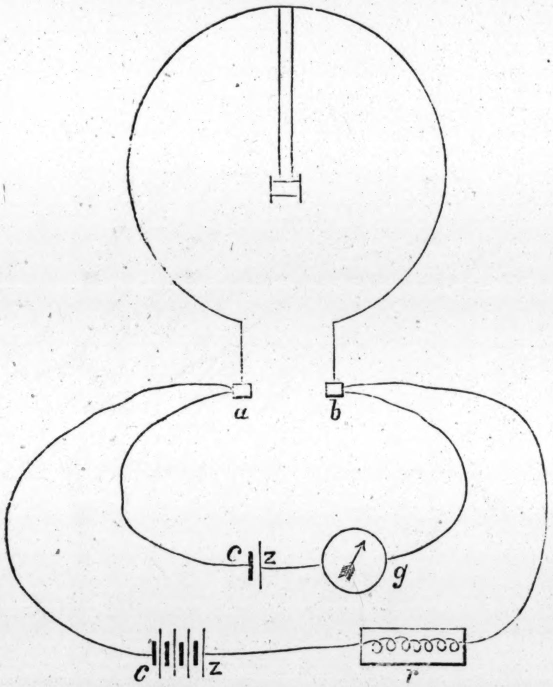
* Communicated by the Author. Abstract of paper read before the Royal Society.

The best method of forming this element is to dissolve pure zinc sulphate to saturation in boiling distilled water. When cool, the solution is poured off from the crystals and mixed to a thick paste with pure mercurous sulphate, which is again boiled to drive off any air; this paste is then poured on to the surface of the mercury previously heated in a suitable glass cell; a piece of pure zinc is then suspended in the paste, and the vessel may be advantageously sealed up with melted paraffine wax. Contact with the mercury may be made by means of a platinum wire passing down a glass tube, cemented to the inside of the cell, and dipping below the surface of the mercury, or more conveniently by a small external glass tube blown on to the cell, and opening into it close to the bottom. The mercurous sulphate (Hg_2SO_4) can be obtained commercially*; but it may be prepared by dissolving pure mercury in excess in hot sulphuric acid at a temperature below the boiling-point: the salt, which is a nearly insoluble white powder, should be well washed in distilled water, and care should be taken to obtain it free from the mercuric sulphate (persulphate), the presence of which may be known by the salt turning yellowish on the addition of water.

FIG. 4.



The electro-motive force of the elements thus formed is remarkably uniform and constant, provided the elements be not connected up and allowed to become weak by working. A long series of comparisons was made between various elements, some of which had been made many months, and it was found that the greatest variation among them all did not differ from the mean value more than one thousandth part of the whole electro-motive force; such a large difference, was, however, very unusual, and might have been due to slight differences of temperature.

Several experiments were made to determine the variation of the electro-motive force produced by temperature, from the mean of which it appears that the electro-motive force decreases with increased temperature in the ratio of about 0·06 per cent for each degree C.; for example, an element gave relative values of 0·9993 at 0° C., and 0·9412 at 100° C., between which limits the decrease appeared nearly proportional to the increments of temperature. These results, however, might be verified with advantage.

The element is not intended for the production of currents, for it falls immediately in force if allowed to work on short circuit. It is intended to be used only as a standard of electro-motive force with which other elements can be compared by the use of the electrometer or condenser, or other means not requiring the use of a prolonged current. The author finds that the most delicate method of making these measurements is by means of his potentiometer.*

As it was desirable to determine the value of the force of the element in absolute measure and in terms of the British Association units, a very careful series of measurements was made by the electro-dynamometer constructed for the British Association Committee, and referred to in their Report for 1867, and also by means of a sine galvanometer of somewhat novel form.

The following Tables give the results obtained:—

I. *By the Electro-dynamometer.*

Date.		Value of E in volts.	Remarks.
1871.			
Dec. 8.	..	1·4583	3 cells.
9.	..	1·4651	3 cells.
14.	..	1·4616	3 cells.
15.	..	1·4561	3 cells.
15.	..	1·4579	2 cells.
16.	..	1·4586	3 cells.
16.	..	1·4517	3 cells, coil turned 180°.
16.	..	1·4552	2 cells, coil turned back 180°.
16.	..	1·4555	3 cells.
16.	..	1·4535	2 cells.
16.	..	1·4564	3 cells.
18.	..	1·4649	3 cells.
19.	..	1·4562	3 cells, coil turned 180°.
19.	..	1·4558	3 cells, coil turned back 180°.
20.	..	1·4615	3 cells.
20.	..	1·4539	3 cells.
20.	..	1·4551	2 cells.
21.	..	1·4549	3 cells.
Mean		1·45735	Temperature 15·5° C.

II. *By the Sine Galvanometer.*

Date.		Value of H.	Value of E.	Remarks.
1872.				
Feb. 9.	..	1·788	1·45605	Galvanometer wound with 8 turns of German silver wire.
9.	..	1·788	1·45457	
9.	..	1·788	1·45400	
10.	..	1·788	1·45809	
10.	..	1·788	1·45669	
11.	..	1·788	1·45799	
18.	..	1·787	1·45566	Re-wound with 28 turns of German silver wire.
19.	..	1·787	1·45671	
19.	..	1·787	1·45680	Re-wound with 27 turns of German silver wire.
20.	..	1·787	1·45752	
20.	..	1·787	1·45645	
24.	..	1·786	1·45522	
24.	..	1·786	1·45492	
Mean			1·45621	Temperature 15·5° C.

We have therefore the mean value of the electro-motive force of the standard-cells, as determined by the electro-dynamometer, 18 observations .. .. 1·45735

As determined by the sine galvanometer 13 observations .. .. 1·45621

Mean value .. .. 1·45678

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* The author has obtained it from Messrs. Hopkin and Williams, 5, New Cavendish Street.

* See "A Treatise on Electrical Measurement," by Latimer Clark, London, 1868, p. 106.

Or, since no importance can be attached to the figures beyond the third place of decimals, 1·457 volt or British Association unit of electro-motive force, equal to 145700 absolute electro-magnetic units.

The value of H, the horizontal component of the earth's magnetic intensity, a knowledge of which is necessary for the determination by the sine galvanometer, was kindly supplied for each day by the Astronomer Royal.

A novel feature in both these series of determinations is the use of an arrangement by which the cells under comparison are not allowed to perform any work or produce any current.

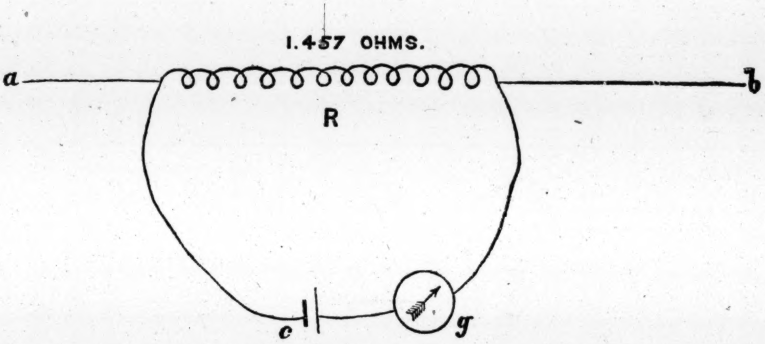
The arrangement is shown in Fig. 4. *a* and *b* are the terminals of the instrument; the standard cell, C Z, is connected to these terminals with an intervening galvanometer, *g*; an auxiliary battery, *c z*, is also connected with similar poles to the same terminals, so that both tend to send a current through the instrument in the same direction.

The strength of the auxiliary battery is, however, so regulated, by means of the rheostat, *r*, and by varying the number of cells, that it just balances the force of the standard cell, so that no current flows through the galvanometer, *g*, or, in other words, the terminals, *a b*, are kept at a difference of potential equal to the electro-motive force of the standard, C Z, the current which flows through the instrument being entirely supplied by the auxiliary battery.

This method has also the advantage of being quite independent of the resistance of the standard cell.

The uses of this standard element to practical electricians are sufficiently obvious. It may be used for determining the electro-motive force of other elements by the use of an electrometer, or by the discharge from a condenser. Or a condenser having a capacity of $\frac{1}{1\cdot457}$ farad charged by the standard cell would contain the British Association unit quantity of electricity (one veber), or $\frac{1}{100}$ of the absolute unity of quantity.

Fig. 5.



It is also of great value for maintaining a current of known strength in any circuit for the purposes of experimental research.

Thus, if it be desired to produce in any circuit, *a b*, a current equal to the British Association current ($\frac{1}{100}$ absolute unit), it is only necessary to insert in the circuit a wire, R, having a resistance of 1·457 ohm, and to connect to each end of this wire the poles of a standard cell, *c*, with a galvanometer, *g*, and to vary the strength of the current in *a b* until no deflection is produced on the galvanometer; the current through *a b* will then be equal to one British Association unit of current, or one veber per second, whatever its length or resistance.

By varying the resistance of R, or by varying the number of elements, *c*, any given current can be steadily maintained through *a b* at pleasure; on the other hand, the value of any given current can be measured by so varying the resistance R that no deflection is produced on the galvanometer. The value of the passing current will then be—

$$C = \frac{1\cdot457}{R} \text{ veber per second.}$$

It is also evident that, knowing the value of E, we may determine the horizontal intensity of the earth's magnetism, H, in any place quickly and simply by means of an ordinary sine or tangent galvanometer.

In fact, the standard of electric potential is second only in importance to that of the standard of electric resistance; and the use of such a standard, combined with an auxiliary battery in the manner above described, admits of a variety of applications, which it is believed will be found of great value in electrical research.

A NEW THERMO-ELECTRIC PILE.

Of the different thermo-electric piles at present invented, that of Messrs. Mure and Clamond best combines the necessary conditions of economy, solidity, and strength. First, this new generator is constructed on a large scale, and in very advantageous commercial conditions; but what is still more important, it may be adjusted so as to be set in action either by the heat of gas, petroleum, or even coke. The elements—iron and galena, or sulphuret of lead—which constitute each couple are well diffused in nature, and are both refractory and unattacked at very high temperatures. They are, moreover, very inexpensive. As 60 couples of this pile can produce an electro-motive force equivalent to that of two Bunsen elements, it may be admitted that the thermo-electric pile can be employed concurrently with hydro-electric piles in point of the electric intensity developed, but far more economically, because the elements are not consumed.

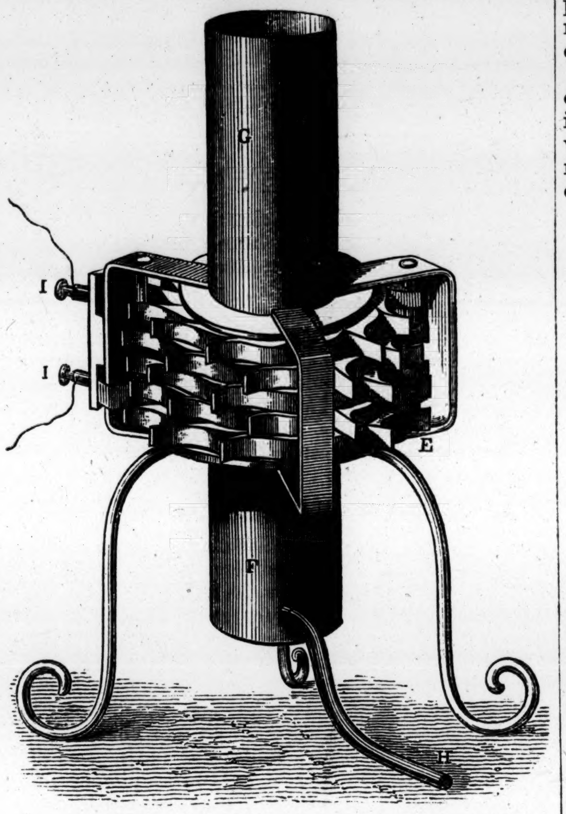
According to Messrs. Mure and Clamond, the weight of copper deposited in one hour, with an expenditure of 150 metres of gas per hour and a pile of 60 elements, may be estimated at 3 grms. 3 decigrms., the surface of the electrodes of copper measuring 72 square centims., and being distant from each other 1 centim. It therefore follows that the kilogr. of copper deposited by this system would amount to 11 francs 80 centimes in Paris, where the price of gas is 30 centimes the cubic metre, and to 7 francs 85 centimes in London, where the price of gas is only 20 centimes. If the cost of gas only is taken into consideration, the kilogramme of copper thus deposited will not come to more than 4 francs.

The disposition of the pile varies according to the system of heating adopted, but it will be necessary only to describe the system of heating by gas. In this disposition, as in all the others, the elements are assembled in a circular manner, so as to form a crown or hollow cylinder, in the centre of which the calorific action is produced, and by placing several crowns of elements thus disposed, one over the other, a pile, as powerful as may be required, is constituted. Figs. 4 and 6 give the perspective view and the section of a pile of 60 couples.

In Fig. 6 the different crowns of elements are seen at E; they are supported by bands of copper, and one of these bears the two terminals I I'. F represents the lower part of the furnace, to which is attached the india-rubber tube, H, to convey the gas. G is the chimney, to which an additional length may be adapted, to increase the draught of the furnace.

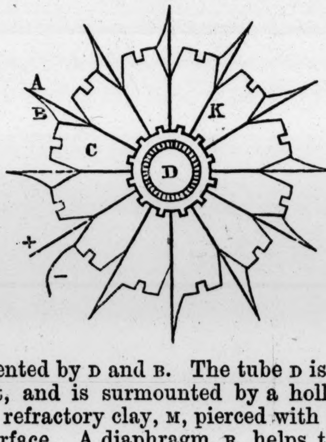
Fig. 7 shows the manner in which the elements of galena and iron are placed in each crown. A represents the sheets of iron which are soldered to the interior extremity of the bars of galena or sulphuret of lead, C, and by bending at B are soldered again to the exterior of these same bars. K represents the sheets of mica placed between the couples, to separate them from each other. Finally, D is the burner formed by two concentric tubes, perforated laterally. By the annular opening the gas is admitted, and by the central opening the air.

FIG. 6.



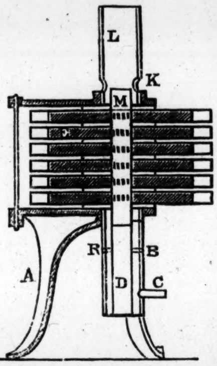
To understand the importance of this disposition of the burner it must be remembered that, from the manner in which it is constructed, the flame of the gas impinges on the juncture of the different elements. A more exact idea of the arrangement can be formed by examining Fig. 8, which represents the vertical section of the apparatus. The two concentric tubes are represented by D and B. The tube D is open at the lower part, and is surmounted by a hollow cylinder formed of refractory clay, M, pierced with holes on its convex surface. A diaphragm, R, helps to distribute the gas more thoroughly in the annular space. The draught-tube or chimney is represented by L; its foot is pierced with holes, K, surrounded by a glass muffle, through which the combustion can be observed. The gas is lighted at one of the orifices, K, and when the superior lengths of the chimney are re-placed the air is rapidly drawn in, and ascends by the tube D, to be discharged by the holes of the cylinder M; it then meets with the gas, and creates before each hole an intense flame, which is projected on the junction of the elements. The flame is regulated by means of the gas-tap, so that it does not reach beyond the upper part of the cylinder M. This burner is heated to redness, and on this account it is made of refractory earth.

FIG. 7.



This part of the apparatus was originally constructed of sheet-iron, but at the end of a series of experiments it was found to be so corroded and worn away that it was abandoned. The use of sheet-iron in piles formerly constructed on this principle may possibly account for the imperfect results that have been obtained.

FIG. 8.



When Messrs. Mure and Clamond came to examine this pile, they, in fact, found the burner completely destroyed, but the elements were quite intact, because the three causes which could lead to their alteration are found to be avoided in the disposition of the apparatus. Thus the fusion of the galena could not take place, as had been thought, because it is not in contact with the flame, and, besides, combustion takes place in an atmosphere of reducing—not of oxidising—gas; neither can the galena be reduced, for reduction can take place only when it is melted,—that is to say, at a temperature of 1100°; finally, the galena cannot decompose under the influence of the current, for it is a moderately good conductor of electricity. Besides, if a chemical action were exchanged between the iron and galena, the current produced would be in contrary direction to the thermo-electric current, and the consequence would be that the latter would resist the reaction.

The largest batteries constructed by Messrs. Mure and Clamond, on the system just described, have been of 150 large couples, with an intensity equivalent to that of 5 Bunsen elements of medium size, and of 560 small couples, arranged in tension, with an intensity equal to that of 60 Daniell elements. The expense of working is about 800 litres of gas per hour in both cases.

CONSEQUENT upon the completion of the organisation of the Postal Telegraph Department, Mr. H. C. Fischer has been appointed Controller of the Central Station.

NEW AMERICAN TELEGRAPH INSTRUMENT.—Messrs. Rogers, of Peekskill, New York, have recently patented the following telegraphic apparatus:—A thin, narrow strip of metal, on which the message is embossed in the Morse characters, is drawn through a transmitting instrument, so arranged that a metal style in communication with one pole of the battery will only touch the upper surface of the characters as the strip passes through the instrument. The under surface of the strip is in communication with the other pole of the battery; consequently, whenever the style comes in contact with an embossed character the circuit is closed, and a signal corresponding to the character is transmitted along the line to the receiving instrument constructed on the Morse principle. It is stated that the re-transmission of messages can be effected very rapidly by this arrangement.

Notices of Books.

The History and Progress of the Electric Telegraph. By Robert Sabine, C.E. Third Edition, with Additions. London: Lockwood and Co. 1872.

Although telegraphy as a science cannot be accounted long-established, it is difficult to say when the nucleus was first formed. Mr. Sabine thinks the history of the electric telegraph to include three distinct periods. "The first of these embraces the earliest observations of electrical phenomena, their classification, and the inquiry into their physical causes. The second begins with the first suggestion of the application of electricity to the transmission of intelligence, and includes the experiments with frictional electricity. The third period dates from the discovery of galvanic electricity to the present time." With this view, Mr. Sabine carries us back to the experiments with amber performed by Thales, of Miletus, about twenty-four centuries ago. First with rapid strides, and then slowly step-by-step, we are brought again to our own day; and from the eminence of knowledge upon which Mr. Sabine then places us, it is interesting to note, in reviewing the ground we have passed over, how much real progress we owe to our own countrymen.

In the question as to the invention of the telegraph, Mr. Sabine holds an independent position. He thinks the title of "inventor of the electric telegraph" an undue honour for any one man, believing our present stage to be the result of the growth of seed sown by many minds. It is difficult to admit this principle *in toto;* and it is equally difficult to draw the line of demarcation between an invention and an adaption, where experimental evidence comes with actual trial of the system. The mechanical ingenuity shown in the different kinds of instrument is so very various, that each may be said to be the inventor of a system; and following Mr. Sabine's idea, each system is like the bricks of a house—separate, indispensable parts of the complete edifice.

Of the value of "The History and Progress" it would be late to say anything; the issue of the present edition affords us an opportunity of recommending the work to our readers.

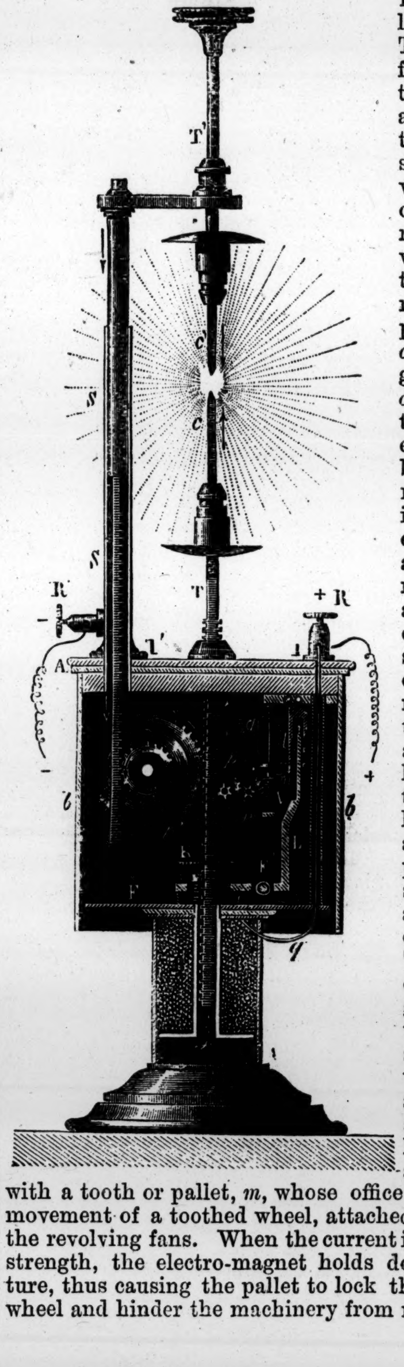
Elementary Treatise on Natural Philosophy. By A. Privat Deschanel, formerly Professor of Physics in the Lycée of Louis-le-Grand. Translated and Edited, with extensive Additions, by J. D. Everett, M.A., D.C.L., F.R.S.E., Professor of Natural Philosophy in Queen's College, Belfast. In four parts. Part III.—Electricity and Magnetism. London, Glasgow, and Edinburgh: Blackie and Son. 1872.

The parts of Professor Everett's translation of Deschanel's "Natural Philosophy" that have been published have already marked the work as a standard one. In this third part the student is indebted more to the translator than to the original author; for the accurate method of treating electrical subjects which has been introduced into this country has not yet been adopted in France. Even Faraday's electromagnetic investigations appear to be still very imperfectly appreciated, or are perhaps misunderstood by French writers. But the student so far from suffering any loss by this omission, has gained several entire chapters from the well-known pen of Dr. Everett.

The descriptions of apparatus given by M. Deschanel are remarkably exact, and here mere translation has only been necessary. We give an engraving and the accompanying description of Duboscq's lantern for the electric light, in order to show how well every one concerned has undertaken his share of the work. For the advanced student there can be no better series.

Duboscq's Regulator.—In Duboscq's apparatus (Fig. 9) there is a train of wheelwork driven by a mainspring contained within the barrel, P, the motion being moderated by means of the revolving fans, *g*. The two racks, S and T, are driven by two wheels attached to the barrel, one of them (the driver of T) having double the radius of the other. One rack thus rises, and the other falls, but the rising rack, T, moves twice as fast as the other. The rack T is that which carries the positive carbon *c;* the negative carbon, *c*', is fixed to the piece T', which travels with the rack S. It has been found by experience that the positive carbon wears away twice as fast as the negative. Hence the adoption of this arrangement, which causes the positive carbon to move double the distance of the other. If the current were generated not by the battery, but by a magneto-electric machine, each carbon would be alternately positive and negative, and it would be necessary to make their velocities equal. The current from the battery enters the apparatus by the binding-screw, R, traverses the coil of the electro-magnet, B B, whence it passes through the rack T to the positive carbon, *c*. From the negative carbon, *c*', it travels to the rack S, and escapes by the binding-screw, R'. The soft iron core of the electro-magnet attracts an armature, K, with a force which depends on the strength of the current. The armature is attached to one arm of the bent lever, L, which turns about a horizontal axis at F' and an opposing spring, S, resists the attraction of the electro-magnet. The upper end of the bent lever governs the movements of a shorter lever, *l*, which turns about an axis at *o*. This short lever is armed at its lower end with a tooth or pallet, *m*, whose office is to stop the movement of a toothed wheel, attached to the axis of the revolving fans. When the current is passing in full strength, the electro-magnet holds down the armature, thus causing the pallet to lock the teeth of the wheel and hinder the machinery from moving; but as

Fig. 9.



the carbons burn away, the resistance increases, the current diminishes, and the strength of the electro-magnet falls off, until the opposing spring is able to overpower it, and raise the armature. This unlocks the pallet from the wheel, and the racks are accordingly driven forward, thus bringing the carbons nearer together, and increasing the current until the electro-magnet acquires sufficient power to prevail over the opposing spring, and lock the wheel work again. A small lever is provided for stopping or starting the motion by hand. The armature can also be screwed up or down, so as to regulate its minimum distance from the electro-magnet according to the battery power employed. The mechanism is inclosed in a metallic box, one side of which can be removed when it is desired to obtain access to the interior.

Students' Column.

THERE are two ways of helping a student. One is by giving direct information; the other by giving information where knowledge may be found and that readily. There are many sources of knowledge that require the pluck of a Livingstone to explore, while others are as oppositely apparent. The Count du Moncel has recently published a work partaking of the latter characteristic; it is entitled an "Exposé des Applications de l'Electricité," and the first volume is devoted to electrical technology—that is to say, to the technical knowledge necessary for the successful application of electricity. The merit of the work is not a little enhanced by the fact that M. du Moncel uses the terms *intensity* and *quantity* of current in our English sense, taking intensity to represent the effect produced by the electro-motive force. In the beginning of his work he makes the self-evident proposition—the proposition is at least self-evident to the *industrious* student—that a knowledge of the laws of the propagation of the electric current is necessary to the understanding of the applications. Then he considers the laws of the propagation of the electric current during a permanent period; with these, embracing Ohm's law, we must suppose the student conversant. But with the laws of the propagation of the current in a variable period every student is not so conversant; and we propose to give here a full consideration of the question. First we will take the Count du Moncel's definitions and remarks. They are these:—

The laws that relate to the propagation of the electric current in a variable period can have reference to little more than the *duration* of the latter, and to the manner in which this duration may be modified according to the different conditions of the circuit traversed by the electric fluid. But in studying the manner in which the tensions were to be found distributed over the conductors at this period of electric diffusion, Ohm had been led to a formula, rather complex, it is true, but from which the following very remarkable result was obtained, viz., *that the time necessary for the permanent establishment of the tensions is proportionate to the square of the lengths of the circuits*. This law, as we have already said, had remained unperceived, and those who knew of its existence did not wish to acknowledge it. Besides, it was necessary to verify it experimentally, and this was no easy matter, since the duration of this variable period in the circuits ordinarily arranged by experimentalists is, so to speak, instantaneous. It was then necessary, in order to obtain moderately conclusive results, to operate on telegraphic circuits of very great length, or on circuits arranged so as to conduct the electricity very slowly. Some threads of cotton were stretched over insulated supports. These threads are conductors only by means of the slight damp stratum which is deposited on their surface; and it is this method that was employed by M. Gaugain in his researches, and in those now under consideration. The other system of experimenting has been employed in France by M. Guillemin, and in England by Messrs. Varley, Fleeming Jenkin, and Wheatstone; all have arrived at conclusions of the highest importance, not only in a scientific, but in a practical point of view. It can be seen at first sight, from the manner even in which the question of the variable period is stated, that the phrase *duration of propagation* may be understood in two ways, *absolutely* and *relatively*.

The duration of absolute diffusion is the time which elapses between the moment when electrical communications are established, and that in which a determined section of the conductor acquires a tension, the positive value of which is given, without considering the limit of tension that it may have.

The duration of relative propagation is the time which elapses between the moment when electrical communications are established, and that in which the tension of a determined section of the conductor is a given fraction of the tension limit that it may attain. It is consequently intimately connected with the value of this tension limit. In order to comprehend precisely the two ways of regarding the duration of the variable state, let us suppose that two circuits of the same dimensions, l and l^1, are considered, of which the one l^1 shall have a greater conductibility than the other; it is clear that if one of the points of the circuit, l^1, attains at the end of a time, t, a certain tension, u, the corresponding point of the conductor, l, will not be able to attain in the same space of time and with the same electric source the tension u; and in order that the latter may be obtained, a longer time, t^1, will be necessary, which will depend on the greater or less facility with which the electric current can flow across this new conductor. Now it is this time, longer or shorter, $t\ t^1$, which constitutes the absolute duration.

The relative duration, on the contrary, supposes that only a greater or less portion of the total duration, corresponding to the establishment of the permanent state, be considered, and it may be readily imagined that the duration corresponding to this fraction must equally vary according to the conditions of the conductor. But as, from calculation, the duration corresponding to the permanent state is infinite, it follows that the duration of the variable state, as is proved by experiment, is never more than a relative one, which may come rather nearer to the corresponding duration at the permanent period than the fraction under consideration does to the unit. However, in practical conditions, nine-tenths of this maximum intensity may be regarded as representing it sufficiently well, and, consequently, when we speak of duration of the variable state, we mean that of the relative propagation, that is to say, of the duration necessary for a current to attain nine-tenths of the maximum intensity corresponding to the permanent state.

From inverse reasoning, the time necessary for the complete discharge of a conductor will be equally unlimited, but the latter may be regarded as sufficiently accomplished when it attains nine-tenths of the total discharge. This fraction $\frac{9}{10}$ is that which Messrs. Varley and Thomson have always adopted in their calculations relative to propagation of the electric fluid over telegraphic lines.

These conditions of duration being thus stated by M. du Moncel, it remains to be seen in what our English physicists differ, and the cause of the difference; and in pursuing the subject we shall consider the laws that relate to the one or the other of these durations.

Electrical Science in Foreign Journals.

(We intend to devote this column to a list of Electrical Memoirs published in Foreign Journals during the month. Those of importance will be either translated in full or given in abstract.)

Comptes Rendus Hebdomadaires des Séances de l'Academie des Sciences, No. 15, October 17, 1872.

Galvanic Reduction of Iron under the Influence of an Electro-magnetic Solenoid.—By M. Dumas, in the name of M. Jacobi.—The laws laid down in this pamphlet submitted to the Academy have been previously made known to electricians by M. Jacobi.

The Induction Currents developed in Gramme's Machine.—By M. J. M. Gaugain.—The completion of an exhaustive paper on this subject. The first communication appeared in the *Comptes Rendus*, t. lxxiv., p. 138. The experiments show that currents of varying intensity are obtained with variation in speed of the coil of the machine. Comprehension of the other results depends upon a knowledge of the former paper.

The Efficiency of Lightning Conductors.—By M. W. de Fonvielle.—A statement of the result of M. de Fonvielle's visit of inspection to England as member of the Commission presided over by Mr. James Glaisher. St. Paul's Cathedral is considered to be the model upon which buildings should be fitted with conductors.

No. 16. October 14.

On the Action of Conductors disposed symmetrically about an Electroscope.—By M. Ch. V. Zenger.—It is known that static electricity always appears upon the surface of conductors; and the conditions under which there is neither communication or induction of electricity by an electrified conductor on an interior body, conductor or not, are:—1. That the two bodies should be in contact at the moment of charging. 2. That the exterior conductor be disposed symmetrically around the interior body, in order to protect against electrical induction. This electrical inertia can be shown by the following apparatus. In the middle of a circular plate of brass, insulated on a glass foot, is arranged a delicate gold-leaf electroscope, enclosed in glass, and terminating in a button of brass, to which is fixed wires of brass bent in different forms, but so symmetrically arranged that by further bending bodies of revolution, for example, a sphere or a paraboloid may be obtained; the axis of rotation is in the direction of the gold leaves. This apparatus when charged so that sparks are given from the wires shows upon the gold leaves no trace of electricity. The wires may be cut without affecting the leaves; but directly the symmetry of the body is destroyed the gold leaves are set in motion.

On the Action of Carbon-dust heaped around the Negative Electrode in Carbon Piles.—Note by M. Th. du Moncel. This interesting paper we shall give in detail.

No. 17. October 21.

A Note by M. Malessart relative to a new electromotor, obtained by a particular disposition of the electromagnets.

Annales de Chimie et de Physique, October, 1872.

This number contains no information relating to electricity.

Annalen der Physik und Chemie. No. 8 and 9, 1872.

These numbers contain nothing relating to electricity; but there is a translation of Professor Wright's paper "*On the Influence of Ozone upon Vulcanised India-rubber.*

Polytechnisches Journal (*Dingler*). **Band ccv., Heft 5.**

This number contains no article of interest in the branch of physical science to which we give attention.

Les Mondes, October 10, 1872.

Demonstration of the Formulæ of Two Currents.—By M. J. Bertrand.—A note upon Ampère's law.

Bulletin du Musée de l'Industrie de Belgique, September, 1872.

The Manufacture of Standards of Length by the Galvanotype Process.—By M. Jacobi.

Application of Electricity to the Firing of Mines.—By M. Cuchez.

City Notes.

During the past four weeks a decided impulse has been given to the telegraphic market, the fluctuations in which were for some time previous comparatively unimportant. The first circumstance which led to greater activity was the announcement that the Government of Brazil had at length granted a concession for the laying of a cable to unite this country with South America, *viâ* Lisbon. The importance of this new trunk line will be enormous, opening up, as it will do, communication with the markets of Brazil, the Argentine Confederation, Chili, Bolivia, and Peru, in which countries, it may be remarked, the telegraph system is now being developed with great rapidity. But the chief cause of the impetus has been the opening for traffic, on the 21st ult., of the British Australian Company's cable, which affords direct communication between London and Melbourne, and thence on to Hobart Town, in Tasmania. Mutual congratulations were exchanged between the Lord Mayor of London and the Mayor of Adelaide on the successful completion of this enterprise, which, according to Mr. William Abbott's circular, has led to an extension of the class of investors in telegraph property generally, and a further distinct improvement in quotations. This advance does not appear to be a mere spasmodic and unhealthy inflation, but is based on the real merits of the undertakings now before the public. The shareholders in the Australian line will doubtless be glad to hear that the traffic already exceeds what was anticipated. The receipts on the Java section have been for some time sufficient to pay the working expenses of the Company; but now, at this early period of the opening of the entire system, business is crowding in so as to assure success. It is stated that, from experience already gained, a traffic of only 60 messages per day—that is, 30 each way—will be sufficient to pay considerably over 12 per cent dividend on the Australian Company, and to add over 7 per cent to the dividend on the British Extension, and 1 per cent on the whole capital of the amalgamated lines, now known as the Eastern Telegraph Company. In fact, every judicious extension of telegraph lines repays the investor who has patiently awaited the development of the system. At the same time caution is especially necessary when recent successes will probably call many wild schemes into existence. The history of the early days of railway extension may serve as a warning against lending too attentive an ear to projects which have no more substantial basis than the hazardous chances of competition, and are mainly started with a view to the profit of the promoters. For it must be remembered that the existing companies are gradually and cautiously taking effectual measures to meet the due requirements of the public, by contracting for duplicate lines of the best and most improved kind of cable. Thus the Eastern Telegraph Company have resolved to commence the duplication of their line from Falmouth to Lisbon, touching either at Corunna or Vigo; and when this cable is laid, early next spring, the tariff to Spain and Portugal will be materially reduced. The contractors of the French Atlantic Company are now shipping on board the *Great Eastern* the cable for the fourth line to America, which will run direct to New York. The shares of the French Cable Company, after a long period of inaction, seem now to be attracting attention, on account of their relative cheapness. In consequence of the re-adjustment of the joint purse arrangement between this Company and the Anglo-American, the French Cable Company's proportion of the receipts over the Atlantic lines will be increased from 33⅓ to 48 per cent, on the completion of the new cable, which will be submerged next June.

The shares of the China Submarine Cable have been in demand, on account of the advance in the rates for messages to Hong Kong and Shanghai, which have been raised from £4 6s. to £6, while the charge to Japan has been advanced from £5 6s. to £7, per message of twenty words in each case. This rise was in consequence of the temporary collapse of the land lines in Eastern Asia, owing in a great measure to the overflowing of the Amoor river, which caused a gap of 700 miles,—a circumstance which tends to indicate the superiority of submarine cables over land lines for long distances. The Great Northern Telegraph Company, however, now announce that the Siberian lines, which were interrupted for some months, have now been re-established, and that the Company's line to China and Japan is accordingly again in perfect order. Messages for those countries are now accepted at all postal stations.

The Telegraph Construction and Maintenance Company has obtained a recommendation from the Brazilian Government, in making the concession for the new cable, that its manufacture and submerging should be entrusted to this Association. The repairing by this Company of the Australian cable has been well carried out.

The Platino-Brazileira Telegraph Company has been authorised to raise its capital to 6,000,000 milreis, and to open registers for its shares in foreign cities.

At a meeting, held on the 24th ult., of the shareholders of Bonelli's Electric Telegraph Company (Limited), in liquidation, the liquidators announced that, having satisfied the creditors' claims, they are enabled to make a first return of 30s. on each £10, and £15 on each £100 share fully paid, payable on the 7th of November, or following Thursday, at Messrs. W. J. White and Company's, 33, King Street, Cheapside.

The half-yearly coupons of the seven per cent first mortgage building bonds of the (American) Western Union Telegraph Company have been announced as payable at the fixed exchange of 4s. per dollar, on presentation at Grant Brothers' Banking-House, Lombard Street, on and after the 1st of this month. The American papers announce that the annual meeting of this Company was held on the 9th ult., when it was stated that on June 30th, of this year, the Company had in operation 62,032 miles of line, and 137,199 miles of wire, worked by means of 5237 offices. During the past year Mr. Stearn's duplex system has been largely introduced. By this arrangement messages can be transmitted on a single wire in opposite directions at the same time.

A BANQUET takes place to-night (the 15th inst.) at the Cannon Street Hotel, to celebrate the opening of telegraphic communication with Australia, and a wire is to be brought into the room for the purpose of communicating with Australia. A banquet is to be held at Melbourne the same evening. A third will take place at Adelaide, and it is hoped that others will be held at Sydney and Brisbane.

At extraordinary general meetings of the British Indian Submarine, Falmouth, Gibraltar, and Malta, Anglo-Mediterranean, and Marseilles, Algiers, and Malta Telegraph Companies, held on the 1st inst., resolutions were unanimously passed confirming and completing the amalgamation of the companies, under the title of the Eastern Telegraph Company.

The traffic receipts of the Great Northern Telegraph Company, for the month of October last, amounted, on their European lines, to 130,058 francs against 106,957 in the corresponding period of last year. On the China and Japan lines the revenue was 90,690 francs against 60,222 in October, 1871.

The traffic receipts of the Eastern Telegraph Company (Limited), for the month of October, amounted to £31,407, against £27,251 in the corresponding period of 1871.

The directors of the China Submarine Telegraph Company (Limited), in their report issued preparatory to the meeting on the 13th inst., state that they "have thought it advisable to raise the rate of messages between China and London to £6, which they consider to be a fair charge in reference to the length of line traversed and the capital expended. This alteration came into effect on the 15th of October, and will, it is hoped, increase the revenue. The completion of the Australian line will also add to the receipts of this Company. The gross revenue has amounted to £69,109, and the expenses to £16,328, showing a balance of £52,780, which, after the deduction of income tax and interest on debentures, leaves a nett profit of £50,943. The directors have already paid three interim dividends, equivalent to 6 per cent per annum, and they now declare a dividend of 2 per cent, making a total of 8 per cent for the year, carrying forward £8943 to reserve."

THE Northern Telegraph Company has obtained from the French Government a concession for laying a cable from a point on the coast of France, which will probably be Dunkirk, to a point on the west coast of Jutland.

The report of the West India and Panama Telegraph Company has been issued for the past year. The receipts amounted to £27,950 18s. 3d., and the expenses to £19,471 6s., leaving a balance of £8479 12s. 3d. These receipts have almost entirely been derived from the eastern section of the Company's line to Demerara, which has only been opened throughout for about six months, while the expenses have been as large as though the whole system were in full work.

ATMOSPHERIC ELECTRICITY.—M. Volpicelli has recently considered the best way of observing atmospheric electrical phenomena. Two different methods have hitherto been employed for determining, at any given time, the quantity and quality of the electricity present in the atmosphere. The first is that of Franklin. The second arrangement, that of Peltier, is to discharge into the air a metallic point connected with an electroscope. M. Volpicelli, having experimented with the two kinds of apparatus, found that they often yielded different results. When the air was still, the projected point yielded more electricity than the fixed one, and sometimes the former, on rising, showed positive, while the fixed point was indicating negative, electricity. Obviously one of these systems is wrong, and according to M. Volpicelli it is that of Peltier, where the metallic point is projected into the atmosphere. He remarks that the earth being a negatively electrified body, every isolated conductor is positively electrified while rising in the air, and negatively so as it falls. M. Volpicelli states, as the result of his experiments, that a fixed metallic point ought invariably to be used in observing the electrical phenomena of the atmosphere, as he believes that a moving point will almost always give indications which are more or less incorrect.

TELEGRAPH SHARE LIST.

Amount per Share.	Name of Company.	Amount paid up.	Oct. 17th.	Oct. 24th.	Oct. 31st.	Nov. 7th.
£		£				
Stock	Anglo-American (Limited)	100	118 120	119 121	126 128	126 128
10	British Australian (Limited)	All	8 8½	8⅞ 9⅛	9⅞ 10⅛	9½ 9¾
10	British Indian Extension (Limited) ..	All	11½ 12	12 12½	14 14½	14½ 14¾
10	China Submarine (Limited)	All	9 9½	9¼ 9½	10 10¼	10 10¼
10	Cuba (Limited)....	All	9 9½	8¾ 9¼	9¼ 9¾	9¼ 9¾
10	Eastern (Limited)	All	9⅝ 9⅞	9⅝ 9⅞	10¼ 10½	10¼ 10½
10	Great Northern	All	10¾ 11¼	10¾ 11¼	11 11½	11 11¼
25	Indo-European (Limited)	All	13 15	13 15	13 15	14 16
10	Mediterranean Extension (Limited) ..	All	6 6½	6 6½	6½ 7	6¾ 7¼
10	Ditto 8 per cent Preference ..	All	11½ 12½	11½ 12½	11½ 12½	12 13
10	Panama and South Pacific (Limited)	2½	— —	— —	— —	— —
8	Reuter's (Limited)	All	10½ 11	9¾ 10½	9½ 10½	9¾ 10½
20	Soc. Transatlant. Fran. (Limited)	All	21¼ 21½	21⅜ 21⅝	22¾ 23¼	22¾ 23
20	Ditto New	15	par ½ pm.	par ½ pm.	1¼ 1¾ pm.	1¼ 1¾ pm.
Stock	Submarine	100	215 225	215 225	215 225	215 225
1	Ditto Scrip	All	2 2¼	2 2¼	2 2¼	2 2*
10	West India and Panama (Limited) ..	All	6 6½	6¼ 6¾	6¾ 7	6¾ 7¼
1000 dls.	West Un. U.S. 7 per cent 1st M.B. ..	All	204 207	204 207	204 207	— —

Patents.

Communicated by Messrs. Vaughan and Son, Patent Agents, 54, Chancery Lane, London.

Applications for Letters Patent.

3109. G. B. McK. Ross, Ardgay Cottage, Ross, N.B., "Improvements in preserving telegraph poles, the posts of wooden fencing, and other similarly exposed or partly embedded wooden surfaces, and in the means employed therefor."—Dated October 22, 1872.

3167. T. A. Redpath, Hanover Square, and W. A. Sherring, Mile End, Middlesex, "Improvements in the mode of and means for producing magneto-electric power, and for applying said power to train-signalling and to other purposes."—Dated October 25, 1872.

3206. W. A. Lyttle, Hammersmith, Middlesex, "Improvements in the means and apparatus for attaching telegraph wires to insulators, in the construction of insulators specially adapted to such apparatus, and also in the construction of protecting shields and guards for use therewith, which improvements are partly applicable to existing forms of insulator."—Dated October 29, 1872.

3230. E. W. Jennings, Portland Place, Middlesex, "Improved means of and apparatus for preparing, transmitting, and receiving telegraphic despatches."—A communication from D. Craig, New York, U.S.A.—Dated October 31, 1872.

3262. G. Zanni, City Road, Middlesex, "Improvements in magneto-electric railway block, and other day or night signalling instruments or apparatus, and in means for communicating signals from one part of a railway train to another."—Dated November 2, 1872.

PATENTS GRANTED.

767. A. Schanschieff, St. Petersburg, Russia, and Taunton Terrace, Middlesex. *Apparatus for facilitating telegraphic signalling upon railways.* Dated March 14, 1872.—In this invention a fixed commutator is arranged to the pointsman's box and a portable instrument attached thereto, so that the guard who carries the instrument can communicate with the next station. Cannot be described apart from drawings.

769. A. Schanschieff, St. Petersburg, Russia. *Apparatus for receiving telegraphic signals and despatches.* Dated March 14, 1872.—An endless cord actuated by weights is the motive power of the Morse instrument, and paddles in a trough of water are employed for determining the speed of the paper ribbon, and also for regulating the marking or inking appliances, the springs and the usual clockwork of the Morse instrument being dispensed with. Cannot be fully described apart from the drawings.

807. D. Graham, Glasgow. *Electric-bell apparatus.* Dated March 18, 1872.—This invention combines an improved battery, with indicating apparatus, and contact-maker. The battery consists of one or more cells of glass, each of which has placed on the bottom of it a disc of copper or lead. A grating of zinc is placed above the copper, and an earthenware cup is rested on the zinc, with a tube which is formed on it, projecting down through a central hole in the zinc. Parchment paper is tied over the bottom and round the sides of the zinc, and the cell is completed by filling in a solution of zinc sulphate, and placing crystals of copper sulphate in the earthenware cup. The indicating apparatus is arranged in a case, the front of which is formed with a number of vertical grooves, in each of which there slides a knob, having fixed to the back a catch projection, which fastens upon a corresponding projection on a strip of iron held by a spring blade. The strip of iron is adjusted within attracting distance of two small electro-magnets, which, when in action, draw it back, and occasion the falling of the knob. The coiled wires have each one end joined to its respective communicating wire, but all the other ends are soldered to a single conductor, which proceeds onwards to the bell. The bell will thus be rung on the closing of the circuit through any one of the several communicating wires, whilst the dropping of the corresponding knob will indicate which wire is used in any case. The contact-maker consists of an elastic metallic diaphragm fixed over a cavity in a piece of wood or other suitable non-conductor, one of the circuit wires being put in metallic communication with the diaphragm, and the other with a metal button in the cavity.

809. I. L. Pulvermacher, 168, Regent Street, Middlesex. *Electro-conducting and electro-generating apparatus or appliances for medico-electric and other purposes.* Dated March 18, 1872.—1. An electro-conducting and electro-generating plaster rendered conductable by metallic surfaces grouped in alternate order with the sticky substance which causes the plaster to adhere to the body. 2. Electro-conducting and electro-generating respirators, composed of wires in connection by means of flexible conducting cords with the poles of a battery carried on the person or otherwise. The electro-generating respirators are composed of wires of alternate positive and negative metals and an absorbent material.

823. S. E. Holten, Gracechurch Street, London. *Mechanical writing instruments, applicable for reporting and other purposes.* Dated March 19, 1872.—A writing ball, Patent No. 1385, 1870, is employed, but the lower ends of the pistons are in a line and have blunt points, which when depressed, form indents across a paper riband moved by clockwork and rendered

conductable. A set of electro-magnets of equal number with the pistons, the keepers having types, are arranged so that when depressed they may print on the white paper band along its edge by means of a carbonised band moving in the opposite direction. Fixed metallic points are arranged diagonally under the paper, and when the indents made in the paper by the pistons touch any one of these points, contact is established, the circuit closed, and the corresponding electro-magnet attracts its keeper, which prints the desired letter on the paper band. When past the point the circuit is broken and a spring brings the keeper back.

828. W. R. Lake, Southampton Buildings, London. *Printing telegraphs.* Dated March 19, 1872.—The shaft of the type wheels is supported upon the pointed or conical ends of screws. The inking roller is made of discs of woven cloth clamped between heads, and is mounted so as to slide with the type wheels. The type wheel, magnet or the impression magnet or both are mounted upon yokes. The shield that prevents an impression from the type wheel not in use is made of a thin spring plate. Under some circumstances, in telegraphs with two adjacent type wheels the type wheels should be moved by separate step-by-step motions. There is one electro-magnet for the two type wheels. There is a transverse bolt in the armature lever that unlocks and locks the levers. It is necessary that both type wheels be first brought to the dash or zero point, so as not to be out of unison when the bolt is changed. Sometimes an independent electro-magnet is employed to give motion to this transverse bolt. The parts are positioned so that a slight movement is allowed the printing lever when the edge of the disc is in the fork. The type wheel is moved by an armature lever and paul and step-by-step motion. The paul that moves the type wheel is drawn aside by a stationary stop, so as not to take more than one tooth at a time.

820. W. R. Lake, Southampton Buildings, London. *Printing telegraphs.* Dated March 19, 1872.—This instrument relates to an invention intended to transmit and to receive. When used to transmit, a small magnetic motor driven by a local battery makes and breaks the main circuit, and the pulsations operate through a magnet in the transmitter and in the receiver. When a finger-key at the transmitting station is depressed the type wheel of the machine is stopped, an arm causes the simultaneous stoppage of pulsations over the main line, arresting all the type wheels at the same point, and the impression is made in consequence of the pause that ensues. The movement of the impression lever breaks its own circuit. The rapidity of the type wheel lever is such that the printing magnet does not have time to become sufficiently charged to move the printing lever before the circuit to the said magnet is broken. The pulsator is made of alternate conducting and non-conducting surfaces, and is stopped by the key acting through an arm and a sleeve on the type wheel shaft with an inclined slot that moves a slide, and finger that takes a catch on the pulsator.

832. C. A. McEvoy, London Ordnance Works, Bear Lane, Southwark, Surrey. *Connecting electric cables and conductors.* Dated March 19, 1872.—This invention relates to a method of connecting the ends of electric cables for use with torpedoes and for other purposes. A hollow coupling is employed, which takes hold of the external projecting wires of the cables, and the connection of the electric conductors is made within the hollow coupling, where no strain can bear upon it. To connect two insulated conductors, a cylindrical metal box is employed, made in two parts, which screw together, the box being lined with vulcanite, or containing vulcanite supports for the wires.

2970. B. J. B. Mill. *Electro-magnetic clocks.* Dated October, 9, 1872. This invention seeks to reduce the spark, and entirely avoid its deleterious consequences, by immersing the contact-points in a liquid solvent or medium, such as kerosene or other suitable liquid, preventing the deterioration caused by the deposit of an exceedingly thin non-conducting film on the contact surface of the rheotome by the continued action of the spark, which is generated there at each interruption of the electric current. As an additional safeguard of this vital necessity of continued electrical contact, the inventor has contrived and adopted a sparkless current shifter. By this expedient the deleterious consequences are obviated through the entire suppression of any sensible spark. Electric clocks are further liable to a failure of their rheotomes. They may fail occasionally to make electrical contact, or may by a kind of rebound, make a double contact by a single impulse of the primary. Defective performance of the secondaries occasionally arises from the action of atmospheric electricity, which is apt to derange the motions of such secondary clocks, by moving them forward in advance of the time of their primaries. To obviate these sources of error, the inventor interposes between the electro-magnetic helix, and the train of wheels which move the hands of the secondary clock, a secondary pulsator.

POST OFFICE TELEGRAPHS.—The total number of messages forwarded from postal telegraph stations in the United Kingdom during the week ended October 19, 1872, and during the corresponding week of 1871, were:—October 19, 1872, 313,388; October 21, 1871, 256,377; showing an increase in the week of 1872 on that of 1871 of 57,011. During the week ended October 26, 1872, and during the corresponding week of 1871:—October 26, 1872, 316,166; October 28, 1871, 257,991; showing an increase in the week of 1872 on that of 1871 of 58,175. And during the week ended November 2, 1872, the number was 312,045, being an increase of 73,786 as compared with the corresponding week of last year.

POSTAL TELEGRAPH OFFICES.—On the 1st inst. telegraph offices were opened at the following places:—England—Aston, near Rotherham; Bolton, Derby Street; Burton-on-Trent, Station Street; Cross Hills, near Leeds; Gayton, near Lynn; Harling, near Thetford; Haworth, near Keighley; Hingham, near Attleborough; Kineton, near Warwick; Leeds, Market Street; Mexborough, near Rotherham; Narborough (Norfolk), near Swaffham; New Buckenham, near Attleborough; Sheepshead, near Loughborough; Sheffield, Saville Street; Silsden, near Leeds; Sutton Benger, near Chippenham; Swinton, near Rotherham; and Whitwell, near Chesterfield. Scotland—Milngavie, near Glasgow; Poolewe, Dingwall; Strontian, near Fort William; and Uig, near Portree. The Culleybackey Station (Belfast and Northern Counties Railway, Ireland) has been opened for postal telegraphy.

Societies' Meetings for the Month.

TELEGRAPH ENGINEERS.—Nov. 27 at 7.30 p.m.; Council Meeting at 6.30 p.m.

METEOROLOGICAL SOCIETY.—Ordinary Meeting, Nov. 20th at 7 p.m.; Council Meeting at 6 p.m.

To Correspondents.

WALTER HALL.—Your communication will appear in our next issue.

H. YEATES.—The account of experiments with induction-coil is unavoidably crowded out; will appear in our next.

J. WILSON.—We shall enter fully into the question of operators' salaries. There is much merit due to, and many reforms needed in, the department to which you belong.

Sir Charles Wheatstone; R. S. Culley; C. W. Siemens; Latimer Clark; R. Sabine; W. H. Preece; S. E. Phillips; C. V. Walker; F. C. Danvers; C. Brooke; J. Faulkner; Dr. Russell Reynolds; W. H. H. Clark (Philadelphia); H. G. Erichsen; E. Rosenbusch (Malta); Indo-European Telegraph Co.; Anglo-American Telegraph Co.; and J. Browning are thanked for their communications.